



# NASA Procedural Requirements

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 (NASA Only)**Subject: Facilities Maintenance and Operations Management****Responsible Office: Facilities Engineering and Real Property Division**

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## Chapter 1. NASA's Facilities Operation and Maintenance Program

### 1.1 Introduction

1.1.1 NASA's facilities operation and maintenance philosophy is to support NASA's mission by aggressively and proactively pursuing and adopting the safest, most cost-effective, and best blend of Reliability Centered Maintenance (RCM) techniques, sustainability, safety procedures, and other best practices to provide safe, sustainable, efficient, and reliable facilities.

1.1.2 NPD 8831.1, Maintenance and Operations of Institutional and Program Facilities and Related Equipment states that the policy for managing facilities maintenance, in support of the stated NASA policy, while following good business practices and minimizing life-cycle facilities costs, is the following:

a. Provide maintenance and repair of facilities and collateral equipment that:

1. Protects the health and safety of personnel.
2. Protects and ensures good stewardship of the environment.
3. Protects and preserves NASA's capabilities and capital investment.
4. Reduces energy consumption.
5. Enables mission performance.

b. Manage and perform facilities maintenance work cost effectively and efficiently by using state-of-the-art maintenance management systems and RCM techniques. Management systems shall, as a minimum, include a standardized and meaningful annual work plan, accurate facility condition assessment techniques, and NASA-owned (NASA- or contractor-maintained) Computerized Maintenance Management System (CMMS) databases.

c. Use accepted standards as a guideline to assist in determining facilities' maintenance funding requirements, such as NASA's Deferred Maintenance analysis, NASA's Facility Sustainment model, and the National Research Council's (NRC) recommended 2- to 4-percent of the facility's current replacement value for its facilities and equipment maintenance and repair program.

d. Continuously and proactively improve technical and managerial processes to minimize life-cycle maintenance and repair costs. These include Centers' designating a single point of contact to communicate and coordinate facilities maintenance and management issues with NASA Headquarters for maximum efficiency and effectiveness; benchmarking and the identification of "best practices"; preparing and adhering to annual and five-year maintenance plans; performing self-assessments and applying reengineering or process-improvement techniques where appropriate; applying NASA RCM principles, as detailed in the NASA Reliability Centered Maintenance Guide for Facilities and Collateral Equipment, in program development and improvement; implementing Predictive Testing and

Inspection (PT&I) techniques in maintenance as well as new construction acceptance testing, where appropriate and whenever possible; and maximizing the population of available CMMS databases.

e. Provide for the lowest life-cycle costs, improve the safety, and establish initial baselines for the subsequent PT&I of facilities and equipment through the acceptance process by enforcing the construction contractor's quality control responsibilities during construction and particularly at the time of equipment acceptance.

f. Use performance-based contracts with clearly defined scopes to capitalize on the contractor's experience and ingenuity; contract for results and not just best efforts; maximize value through the use of fixed pricing and unit cost pricing with competition; improve quality through contractor selection based on past performance, measuring against prescribed, objective, and measurable performance standards; and follow a formal Quality Assurance Plan.

g. Implement processes and technologies recommended by the NASA Operations and Maintenance of Facilities Innovations Team (OMFIT) and Engineering and Construction Innovations Committee (ECIC) to improve the operations and maintenance of existing facilities over their entire life cycles and to promote the sustainability concept of maintainability for new construction, renovations, rehabilitations, and repairs.

## 1.2 Center Participation

1.2.1 Videoconferences. NASA Center maintenance management personnel are strongly encouraged to participate in the monthly facility maintenance video/teleconferences. These conferences provide an opportunity to educate personnel in new tools available, facilitate the adoption of best practices, and disseminate information and lessons learned Agency wide.

1.2.1 Facility Maintenance Conferences and Workshops. NASA Center civil service and support contractor maintenance management personnel are strongly encouraged to attend facility maintenance conferences and workshops. These conferences and workshops are an opportunity to exchange ideas, make contacts with other Centers' maintenance personnel, and learn new maintenance practices that can be used in Center programs.

1.2.2 Center Points of Contact. Each Center and Component Facility will establish a single point of contact for interfacing with the NASA Headquarters, Facilities Engineering and Real Property Division's Maintenance Team concerning facilities maintenance matters.

## 1.3 Pillars of the Maintenance Program

1.3.1 Safety. Per NPD 8700.1, NASA Policy for Safety and Mission Success, it is NASA's policy to protect the public, astronauts, and pilots; NASA workforce; high-value equipment and property; and the environment from potential harm as a result of NASA activities and operations by factoring safety as an integral feature of programs, technologies, operations, and facilities. Safety is the Agency's number one core value. Accordingly, in the operations and maintenance of a Center's facilities, the maintenance organization shall make every effort to ensure that this NASA policy for safety is adhered to in all of its activities and that the procedural requirements contained in NPR 8715.3, NASA General Safety Program Requirements, are incorporated into their daily activities.

1.3.2 Maintenance Funding and Reporting. As the steward of its facilities, NASA is responsible for reporting to higher authority, Office of Management and Budget (OMB) and the Congress, on ways its facilities maintenance funds are spent. To make this possible, Centers shall use Functional Management System (FMS) codes to account for and report to Headquarters their facilities maintenance funding. Additionally, for accuracy and credibility, it is necessary for Centers to capture all costs associated with facilities maintenance work. NASA has adopted the National Research Council's recommendation that 2- to 4-percent of the Current Replacement Value (CRV) should be targeted for only facilities maintenance and minor repair. Refer to chapter 2 of this NPR for more detailed information.

1.3.3 Maintenance Management Program. Maintenance management consists of all aspects of defining the requirements, job planning, and job execution and analysis. An effective facilities maintenance management program maximizes the useful life of the facilities and equipment, minimizes unplanned downtime, provides an improved work environment, and produces information to make management decisions, all within a given resource level. The approach is mission focused and customer oriented. The challenge for NASA, both at Headquarters and across the Agency, is for continuous improvement within the available resources, as measured and monitored by meaningful and reliable Headquarters and Center performance metrics and trend analysis, and capitalizing on the very best and latest information available through benchmarking and the adoption of best practices. Refer to chapter 3 of this NPR for more detailed information.

1.3.4 Annual Work Plan. The annual work plan provides Centers with a vehicle to display long- and short-range facility requirements by articulating their needs based on mission impact and the most probable facility availability outcomes under varying budget scenarios. The plan must be designed so that it can be integrated smoothly into NASA's strategic management process, afford Center Facilities Maintenance Managers and other senior managers the ability to make risk-based decisions regardless of the budget environment, and also allow Center facility maintenance organizations to pursue and measure their continuous improvement efforts. Centers should also

maintain Five-Year Facilities Maintenance Plans for resource planning beyond the Annual Work Plans. Refer to chapter 4 of this NPR for more detailed information.

**1.3.5 Maintenance Execution.** Maintenance execution consists of work request, work reception and tracking, work order preparation, and work execution. The maintenance execution phase should be developed based on the guidance of this NPR, best practices, and available resources and should be customized to address most satisfactorily the needs of each Center. Refer to chapter 5 of this NPR for more detailed information.

**1.3.6 Computerized Maintenance Management System.** Facilities maintenance managers at NASA Centers are to use modern maintenance management systems and methods to control work activities, account for resources, and monitor and report work execution through the use of various industry standard metrics and other management indicators. All Computerized Maintenance Management System (CMMS) databases must remain the property of NASA, regardless of whether, NASA or the contractor populates and maintains them, and any applicable maintenance contracts must explicitly include language to that effect. Refer to chapter 6 of this NPR for more detailed information.

**1.3.7 Reliability Centered Maintenance.** It is NASA's policy to apply Reliability Centered Maintenance (RCM) principles in program development and improvement. Implementing this policy emphasizes the use of RCM concepts and its supporting programs to reduce life-cycle costs of facilities and systems of varying criticality and failure impact on NASA missions. RCM is to be used as early as possible in the planning and design stages to set technical tolerances, performance criteria, and PT&I standards. RCM concepts are to be used by planners, designers, equipment procurement specialists, construction managers, Operations and Maintenance (O&M) civil service and contractor personnel, and anyone else involved in NASA facilities planning, design, construction, equipment procurement, and maintenance and operations. Refer to chapter 7 of this NPR for more detailed information.

**1.3.8 Reliability Centered Building and Equipment Acceptance.** The NASA Reliability Centered Building and Equipment Acceptance (RCB&EA) Guide focuses on reducing facility life-cycle costs (especially infant mortality costs--those occurring in the earliest life-cycle stages) by integrating PT&I techniques into the construction contractor's quality control program for equipment acceptance. In today's tight budget environment for facilities operations and maintenance, it is advantageous to use the construction contractor's quality control function to perform noninvasive diagnostic tests to verify equipment condition and installation prior to the contractor's exit from the job site. The NASA RCB&EA Guide focuses on using PT&I technologies to test and accept new systems during equipment installation, repair, or rework and the contractor's making installation modifications, as necessary, to meet the prescribed standards. The result is an initial database of equipment condition for the subsequent maintenance program, the avoidance of premature wear caused by latent manufacturing defects or faulty installation, better information upon which RCM decisions will be based, longer equipment life, and ultimately minimum overall facility operating costs. Refer to chapter 8 of this NPR for more detailed information.

**1.3.9 Deferred Maintenance.** Formerly known as Backlog of Maintenance and Repair (BMAR), NASA's Deferred Maintenance (DM) shall be the term used in benchmarking with other agencies. With increased funding cutbacks and the need to manage available funding more efficiently, there is a requirement ensuring that NASA's DM is realistic and that any ensuing funding is spent wisely. Refer to chapter 9 of this NPR for more detailed information.

**1.3.10 Facility Condition Assessment (FCA).** FCAs provide NASA Centers with information to properly develop five-year and annual work plans and priorities for facilities maintenance, repair, and revitalization. Headquarters needs adequate FCA information to ensure the proper stewardship over facilities entrusted to NASA, as well as to assist Agency Senior Management and higher authorities in projecting facilities budgetary needs in conjunction with NASA's meeting its mission as directed by the President and Congress. Despite their importance, formal FCAs are time-consuming and costly to perform. Maximum use of RCM procedures and PT&I techniques that monitor facility and equipment condition and continuous inspection that incorporates historic information from the CMMS database, ongoing maintenance and repair efforts, and customer and user feedback are necessary to provide Centers with valuable FCA information that in the past had to be developed manually. This continuous inspection coupled with minimal facility condition inspections provides the FCA without the formal process. Refer to chapter 10 of this NPR for more detailed information.

**1.3.11 Central Utility Plant Operations and Maintenance.** Central Utility Plant O&M is included here because of its close operational and organizational association with facilities maintenance management. The management of utility system inspection and maintenance is directed toward maintaining safety, minimizing system downtime, minimizing cost, and minimizing waste. To provide safety, reliability, high quality, and economical utility services, utilities management must ensure that equipment and distribution systems are maintained in top working order and that distribution line losses are identified and corrected. Standard Operating Procedures (SOPs) must be developed to cover routine operations, startup and shutdown, operator maintenance, preventive maintenance, and other emerging actions such as load shedding. Refer to chapter 11 of this NPR for more detailed information.

**1.3.12 Performance-based Contracting (PBC).** NASA is committed to implementing the use of PBC to the maximum extent possible. Under the PBC concept, the Government contracts for specific services and outcomes, not resources. Contractor flexibility is increased, Government oversight is decreased, and attention is devoted to

managing performance, results, and ultimate outcomes. Contractor/Government partnering is highly recommended to achieve mutually supportive goals. The PBC should encourage the use of contractor best practices and cutting-edge maintenance practices used in the private sector to give NASA the best product. Data Requirements Documents (DRDs) shall be generated that include metric reports as described in this NPR. Refer to chapter 12 of this NPR for more detailed information.

1.3.13 Energy Management and Control System Operations. The Energy Management and Control System (EMCS) is a building automation system that provides remote visibility and monitoring of building systems and utilities. As such, the EMCS is a cornerstone to energy efficiency and for the cost-effective operation and maintenance of modern facilities.

## 1.4 Facilities Maintenance Definitions

1.4.1 In order to implement the policies in NPD 8831.1, Maintenance and Operations of Institutional and Program Facilities and Related Equipment, and the guidance in this document, it is necessary to standardize definitions and have a commonality of all facilities maintenance Agency wide among NASA Centers and the Centers' Component Facilities. This permits the application of uniform measures of facilities condition; allows meaningful, quantitative metrics in terms common throughout the Agency and the ability to statistically analyze variances; enables compiling an information data base using terminology and definitions common to and recognized by commercial software products and other industrial and Government applications; and adds credibility to the NASA facilities maintenance budgeting process through standardization. In addition to the definitions listed in Appendix A, Centers must use the definitions, and specifically the nine facilities maintenance work elements defined in the paragraphs below, to identify, classify, and analyze facilities maintenance trends, to prepare the Center's Annual Work Plan and five-year plan, and for all other Agency-wide facilities maintenance applications:

a. Facility. A term used to encompass land, buildings, other structures, and other real property improvements, including utility systems and collateral equipment. The term does not include operating materials, supplies, special tooling, special test equipment, and noncapitalized equipment. The term "facility" is used in connection with land, buildings (facilities having the basic function to enclose usable space), structures (facilities having the basic function of a research or operational activity), and other real property improvements.

b. Equipment. In NASA, equipment is divided into two categories, collateral equipment and noncollateral equipment. These are defined as follows:

1. Collateral Equipment. Encompasses building-type equipment, built-in equipment, and large, substantially affixed equipment/property and is normally acquired and installed as part of a facility project.

(a) Building-Type Equipment. A term used in connection with facility projects to describe equipment that is normally required to make a facility useful and operable. It is built in or affixed to the facility in such a manner that removal would impair the usefulness, safety, or environment of the facility. Such equipment includes elevators; heating, ventilating, and air conditioning systems; transformers; compressors; and other like items generally accepted as being an inherent part of a building or structure and essential to its utility. Such equipment also includes general building systems and subsystems such as electrical, plumbing, pneumatic, fire protection, and control and monitoring systems.

(b) Built-in or Large, Substantially Affixed Equipment. A term used in connection with facility projects of any type other than building-type equipment that is to be built in, affixed to, or installed in real property in such a manner that the installation cost, including special foundations or unique utilities service, or the facility restoration work required after its removal is substantial.

2. Noncollateral Equipment. Includes all equipment other than collateral equipment. Such equipment, when acquired and used in a facility or a test apparatus, can be severed and removed after erection or installation without substantial loss of value or damage thereto or to the premise(s) where installed. Noncollateral equipment imparts to the facility or test apparatus its particular character at the time (e.g., furniture in an office building, laboratory equipment in a laboratory, test equipment in a test stand, machine tools in a shop facility, computers in a computer facility) and is not required to make the facility useful or operable as a structure or building.

c. Facilities Maintenance. The recurring day-to-day work required to preserve facilities (buildings, structures, grounds, utility systems, and collateral equipment) in such a condition that they can be used for their designated purpose over an intended service life. It includes the cost of labor, materials, and parts. Maintenance minimizes or corrects wear and tear and thereby forestalls major repairs. Facilities maintenance includes preventive maintenance (PM), PT&I, grounds care, programmed maintenance, repair, trouble calls (TCs) (facilities repair), replacement of obsolete items (ROI), and service requests (SR) (Not a maintenance item but is work performed by maintenance organizations). Facilities maintenance does not include fire department protection services personnel, security and custodial services, new work, or work on noncollateral equipment. The elements of facilities maintenance are defined in the following nine paragraphs. Centers should be prepared to report their planned and actual facilities maintenance effort, including costs of parts, labor, and materials by these nine elements when requested by NASA Headquarters.



1. Preventive Maintenance. The planned, scheduled periodic inspection (including safety), adjustment, cleaning, lubrication, parts replacement, and minor repair (no larger than TC scope) of equipment and systems for which a specific operator is not assigned. PM consists of many checkpoint activities on items that, if disabled, would interfere with an essential Center operation, endanger life or property, or involve high cost or long lead time for replacement. PM is the cornerstone of any good maintenance program. A weak or nonexistent PM program could result in safety and/or health risks to employees, much more emergency work, and costly repairs.

2. Predictive Testing and Inspection. Those planned testing and inspection activities for facility items that generally require more sophisticated means to identify maintenance requirements than in PM. For example, specialized tests are used to locate thinning of pipe walls and fractures (e.g., eddy current testing, radiographic inspections, ultrasonic testing, television cameras, or aural leak detectors); to detect roof weaknesses or wet insulation areas (e.g., infrared thermographic viewers or nuclear density devices); to identify large equipment wear problems (e.g., vibration analyzers and oil analysis for wear metals and lubricant properties); and to locate charge or heat buildup in electrical equipment (e.g., infrared thermography).

3. Grounds Care. Grounds care is the maintenance of all grassy areas, shrubs, trees, sprinklers, rights-of-way and open fields, drainage ditches, swamps and water holding areas (lakes, ponds, lagoons, canals), fences, walls, grates, and other similar improvements to land that are included in the NASA Real Property Accountability System, and exterior pest and weed control. The maintenance tasks include mowing, spreading fertilizer, trimming hedges and shrubs, clearing ditches, snow removal, and related work. Included in this category is the cost of maintaining grounds care equipment such as mowers and tractors.

4. Programmed Maintenance (PGM). Planned programmed maintenance consists of those maintenance tasks whose cycle exceeds one year, such as painting a building every fifth year. (This category is different from PM in that if a planned cycle is missed the original planned work still remains to be accomplished, whereas in PM, only the next planned cycle is accomplished instead of doing the work twice such as two lubrications, two adjustments, or two inspections.) Examples of PGM include painting, roof maintenance (flood coat, flashing, patching, incidental repair by replacement), road and parking lot maintenance (overlays, seal coating, and patching), utility system maintenance (pigging of constricted lines), and similar functions.

5. Repair. The facility work required to restore a facility or component thereof, including collateral equipment, to a condition substantially equivalent to its originally intended and designed capacity, efficiency, or capability. It includes the substantially equivalent replacements of utility systems and collateral equipment necessitated by incipient or actual breakdown.

6. Trouble Calls. TCs (a subset of repair) are unplanned and generally called in by telephone or submitted electronically by occupants of a facility (or facility managers or maintenance workers). Where the calls are for nonfacility work (not of a facility maintenance or repair nature) the call must be coded so that it is not included with TCs included in funding level calculations. Examples of nonfacility work are interior pest control and janitorial work, such as cleaning up a spill or cleaning carpets. TCs are composed of two types of work as follows:

(a) Routine Calls. Routine calls are unplanned minor facility problems that are too small to be estimated (usually less than about 20 work hours or \$2,000). They generally are responded to by grouping according to craft and location.

(b) Emergency Calls. Emergency calls require immediate action to eliminate hazards to personnel or equipment, to prevent loss of or damage to Center property, or to restore essential services that have been disrupted. Emergency work is usually a response-type work effort, often initially worked by TC technicians. Due to its nature, emergency work is not restricted to a level of effort such as routine Calls (although in many cases it falls within the work hour and/or dollar limit of routine calls).

7. Replacement of Obsolete Items. There are many components of a facility that should be programmed for replacement because they are becoming obsolete (no longer parts-supportable at the end of service life), do not meet electrical or building codes, or are unsafe but are still operational and would not be construed as broken and needing repair. Examples include, but are not limited to, electric switchgear, breakers, and motor starters; elevators; control systems; boiler and central heating, ventilating, and air conditioning (HVAC) systems and controls; fire detection systems; cranes and hoists; and air conditioning systems using chlorofluorocarbon (CFC) refrigerants.

8. Service Requests. Service requests are not maintenance items, but are so often performed by facilities maintenance organizations that they become a part of the baseline. Service requests are requests for facilities-related work that is new in nature and, as such, should be funded by the requesting organization. Service requests are initiated by anybody at the Center, usually submitted on a form; often require approval by someone before any action is taken; usually are planned and estimated, materials procured, and shop personnel discretely scheduled to accomplish the work. Examples of these requests include installation of an outlet to support a new copier machine, providing a compressed air outlet to a new test bench, renovating an office, and installing special cabinetry.

9. Operations. Operations include those recurring activities required to maintain a facility so that it can reliably perform its intended function, but which are not considered PM, repairs, or PT&I. These activities would include, but

not be limited to, items such as periodic site visits and inspections, equipment logging, central utility or plant staffing, and freeze and storm plan maintenance activities.

(a) General. There are many operational items that are required to maintain the reliability and function of facilities, but which are not part of some central utility or control/monitoring operation. These operations can include items such as logging of small chillers and boilers, monitoring generators and replenishing fuel levels, maintaining refrigerant inventory and records, and freeze and storm plan maintenance activities. These operations are most often performed by the same shops and personnel that perform PM and repair maintenance, but these activities differ from these other categories of maintenance in that they do not intend to perform any identifiable preventive or repair work. Their intended function is only to detect the need of PM or repair activities before a failure or extensive damage occurs. Operations are a necessary element (along with RCM, PT&I, and PM) in establishing a proactive maintenance program.

(b) Central Utility Plant Operations and Maintenance. This category is unique in that it includes the cost of operations in addition to maintenance costs. It should be used only to capture the costs of operating and maintaining institutional central utility plants, such as a central heating or steam plant, wastewater treatment plant, or central air conditioning (A/C) (chiller) plant. The concept is that operators are assigned full time to operate the plant, but they perform maintenance between various operating tasks, making it almost impossible to segregate operational and maintenance costs. Therefore, the costs of the full-time operators (and their materials) are shown in this category. This facilities maintenance element does not include any work outside of the five-foot line of the utility plant or project-type work.

(c) EMCS Work Station or Central Console staffing. This operation plays a key role in most maintenance organizations in that this staff not only operates and monitors sitewide conditions visible on the EMCS, but also often receives trouble calls and notifications. As such, these operators are the focal point in the real-time management of the site maintenance by initiation of work orders or by mitigating or dictating immediate maintenance activities according to the priority and criticality of alarms and calls. Often this operation serves as the only manned maintenance function after normal working hours or on weekends and holidays. No modern facility could operate efficiently and reliably without some level of EMCS operation.

1.4.2 Deferred Maintenance. DM, formerly referred to as Backlog of Maintenance and Repair (BMAR), is the unfunded facilities maintenance work required to bring facilities and collateral equipment to a condition that meets acceptable facilities maintenance standards. The key word is "unfunded." If resources are or will be available to do the work during the current year, the work is considered to be scheduled and is not part of the backlog.

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